

WE CLAIM:

1. An apparatus for generating hydrogen from a feed stream for use in conjunction with a fuel cell, said apparatus comprising:

an inner vessel having a longitudinal axis, sides, a first end and a second end

opposite, said inner vessel having a mixing zone, an oxidation zone, and a

secondary reforming zone, said inner vessel having a layer of insulation

disposed surrounding the sides of the inner vessel;

a core gas conduit located outside the inner vessel and radially distributed about

the longitudinal axis, said core gas conduit having an interior passage and

having a catalytic combustion zone disposed in at least a portion of the interior passage;

a plurality of pre-reforming zones, each of said pre-reforming zones comprising

an annular pre-reforming catalyst zone containing a pre-reforming catalyst,

each annular pre-reforming catalyst zone having a terminal end and an annular

inlet surface, said annular pre-reforming catalyst zone disposed annularly

surrounding at least a portion of the core gas conduit in thermal

communication therewith, said combustion zone being adjacent the terminal

end, said core gas conduit extending through the pre-reforming catalyst zone

beyond the terminal end and beyond the annular inlet surface of the annular

pre-reforming catalyst zone;

a fuel manifold having a fuel inlet in fluid communication therewith;

an inner feed plenum disposed on the first end of the inner vessel in fluid communication with the mixing zone and the terminal end of each annular pre-reforming catalyst zone, the core gas conduit extending through the inner feed plenum to the fuel manifold, said fuel manifold being disposed on the inner feed plenum, said interior passage of the core gas conduit being in fluid communication with the fuel manifold;

an outer feed manifold disposed further distanced from the second end of the inner vessel also partially defining a sealed effluent plenum zone enclosing each pre-reforming catalyst zone and the inner vessel, said sealed effluent plenum zone being in fluid communication with an effluent outlet, the outer feed manifold being in fluid communication with a feed inlet and the annular inlet surface of each pre-reforming catalyst zone;

a flue gas manifold disposed on the feed manifold, said flue gas manifold having a flue gas outlet in fluid communication therewith, the core gas conduit extending through the outer feed manifold to the flue gas manifold, said flue gas manifold being in fluid communication with the interior passage; and

an air preheating zone disposed surrounding the effluent plenum zone and the inner feed plenum, said air preheating zone being in fluid communication with an air inlet, the inner feed plenum, and a preheater outlet,

wherein the upper reforming zone is disposed on the oxidation zone and the oxidation zone is disposed on the secondary reforming zone, the mixing zone being in fluid

communication with the oxidation zone and the oxidation zone being in fluid communication with the secondary reforming zone.

2. The apparatus of claim 1 wherein the mixing zone comprises a reforming catalyst.

5 3. The apparatus of claim 1 wherein the pre-reforming catalyst is a supported metal catalyst selected from the group consisting of nickel, cobalt, platinum, palladium, rhodium, ruthenium, iridium and mixtures thereof on a refractory support.

4. The apparatus of claim 1 wherein pre-reforming catalyst comprises nickel supported on an alumina promoted by potassium.

10 5. The apparatus of claim 1 wherein the inner vessel and the plurality of pre-reforming zones are cylindrical.

6. The apparatus of claim 1 wherein the layer of insulation is effective to minimize heat transfer from the secondary reforming zone to the pre-reforming catalyst zone.

15 7. The apparatus of claim 1 wherein the effluent outlet is disposed adjacent to the inner feed plenum.

8. The apparatus of claim 1 wherein the terminal end of each pre-reforming catalyst is disposed farther distanced from the inner feed plenum.

20 9. A process for the generation of hydrogen in conjunction with a fuel cell using the apparatus of claim 1.